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USED OIL RECYCLING

by

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ABSTRACT

Used lubricating oil is a natural resource which can be recycled in many different ways. Reclamation of industrial oils, reprocessing to yield clean fuels, and re-refining to generate high quality lube oil basestocks can all be used beneficially. Impediments, such as planned blending with hazardous waste streams, complex formulations, and poor economics must be considered when selecting the most appropriate approach. We believe that together the generator, the recycler, and the customer using recycled products can contribute to a positive solution for a potentially major environmental problem.

INTRODUCTION

Used lubricating oil recycling is not a new subject. Throughout this century, entrepreneurs have "discovered" the resource represented by lubricants drained out of crankcases, machinery, and sumps. A wide variety of uses have been marketed. It could be said that used oil recycling was one of the earliest attempts at waste minimization and resource recovery.

Recycling of this commodity is possible because the typical uses of the virgin product do not chemically change the primary compounds making up the lubricant. The statement often heard is that "lube oil does not wear out, it just gets dirty." Research around the world has confirmed this. In addition to picking up dirt, water, and other extraneous materials, lube oils age due to the depletion of additives that provide many of the properties

in which we are interested. These include corrosion resistance and minimal viscosity change over wide temperature ranges.

IMPEDIMENTS

So why has the industry not flurished? Why are a vast majority of used oil recyclers no longer in business? There are several reasons, among which are: a) environmental problems, b) feedstock competition, c) lube formulation complexity, and d) petroleum economics.

Environmental Problems - Inspite of its value as a resource, used oil is still a waste stream to most generators. As such, it often is mixed with other wastes before disposal. This is inadvertently encouraged by the fact that used oil is less expensive to dispose of than many waste streams, especially those considered to be hazardous. In fact, during times of higher crude oil prices, collectors often paid generators for their used oil. It did not take generators long to figure out where to hide their other wastes, since it simply increased the volume of used oil for which they were paid by volume.

It is not unusual to find several thousand parts per million of halogenated solvents in used oil coming into a recycling facility. While there are a few additives in lubricants that might explain a small part of these, most detailed analyses show that the halogens are solvents that have been added after the fact.

Because of this frequent adulteration, some of the natural constituents (such as benzene) found in lube oils, and contaminants introduced during use (such as lead), many environmental agencies have declared used oil to be a hazardous waste. The U.S. Environmental Protection Agency is still considering what to do, not because they disagree with the above points, but because they want to do everything possible to encourage recycling.

The problem with weak regulations is that the volumes of used oil generated each year (well over 1 billion gallons in North America) posses a significant threat to the environment if improper disposal occurs for even a relatively small portion of this material. Several abandoned used oil collection/processing sites in the U.S. are currently being cleaned up under Superfund authorization due to contamination of drinking water supplies and other very serious impacts.

The costs of recycling used oil properly from an environmental standpoint can be high for an operator with small volumes. Analyzing oil to determine what contaminants

are in the feedstock and products to determine whether it is safe to market requires expensive instrumentation. Thus, many of the small operators have gone out of business because they could not increase their volumes collected sufficiently to cover such costs. Others have tried to continue to operate without knowing the composition of what they were selling. The fines, litigation, and loss of business due to an increasingly aware public have forced them out. Given the threat posed by marketing of this material without analyses, these closure are probably reasonable.

Feedstock Competition - There are many potential uses for used lubricating oil. While some of the more humorous ones (application to the skin of pigs to keep them soft) tend to involve very small volumes, there is serious competition for the large volume generator business. The primary pathway has always been to burn the oil as a fuel. This can be done with raw used oil (such as in cement kilns), with fuel oil/used oil blends, or with reprocessed used oil, which has been cleaned up to meet burner and environmental specifications. The price and availability of competing products, such as #4 fuel oil and lubricating oil basestocks, often determine the relative advantages of the competing markets.

Alternative applications like road oiling and mining dust suppression have been largely eliminated due to the ramifications of applying this waste stream directly to the environment. An entire town in Missouri (Times Beach) had to be purchased by the U. S. EPA due to contamination carried by used oil applied on roads and farm areas.

Once again, the smaller the business, the less able it was to survive the competitive pressures. Larger businesses could be more flexible, while also usually having more financial strength to survive short-term changes in the market.

Lube Formulation Complexity - On top of everything else, the manufacturers of virgin lubricants have been working for decades with the additive suppliers to develop better oils that would last longer and perform better. Such resiliency also made oils much more difficult to recycle. Thus, simple processes did not clean up the oil sufficiently and more expensive methods, similar to what crude oil refiners use to generate lubricants in the first place, were required. Once again, the small operations could not afford such capital outlays.

Petroleum Economics - As mentioned above, competition has always been a factor in this business as in all others. However, the used oil recycler is in a somewhat unique position in that both his feedstock prices and product

prices are largely controlled by the same competitor. The major oil companies sell the fuels that tend to establish the value of used oil, and they also sell the higher quality lube oil basestocks that compete with the recycled products. When the total petroleum market declines as it has in the past several years, the margin between those levels shrinks, and the recycler is left with no profits.

TECHNOLOGY

There has been a considerable amount of research completed relative to used oil in the past two decades. A recent literature review found 1200 directly related references during just a portion of that period. This involves both the processing and the analytical requirements.

Reprocessing - The production of a specification fuel from used oil is normally referred to as reprocessing. This usually involves simple settling, filtration, and evaporation of water and low boiling-point contaminants (e.g., gasoline and solvents). The U.S. EPA has established specifications for this type of fuel when marketed to nonindustrial boilers, such as apartment buildings. The analytical requirements include PCB's, flash point, halogens, and selected metals.

Reclaiming - Many industrial lubricants can be recycled with minimal clean-up. Sometimes this is done with in-house equipment at larger facilities. The technology is often very similar to reprocessing, except that the segregated material is rejuvenated for its original use. For example, a used hydraulic oil is reclaimed to meet virgin hydraulic oil specifications. The analytical requirements are dictated by each client, but usually include halogens, flash point, and total ash.

Re-refining - The most advanced of the used oil recycling approaches is the re-refining of the resource into a lubricant basestock. While many techniques have been proposed, only a few have been commercialized. For many decades, completion of the oxidation of the oil using concentrated sulfuric acid was followed by clay adsorption and filtration to clean up any degraded components. However, that process has odor problems and generates an acidic sludge by-product which is difficult to deal with in today's regulatory environment. Further, this process is not satisfactory for many of the more complex formulations described above.

Thus, most of the industry moved to a vacuum distillation step of some sort. The water and low-boiling hydrocarbons are flashed off at atmospheric pressure, then

the lube oil is vacuum distilled in one or two steps. In the initial installations, the re-condensed lube oil was treated with activated clay. However, one now has the oily clay to dispose of, and product quality was not always what it could be.

Currently, the favored technology is to vacuum distill using thin film evaporators and polish the product using hydrofinishing. This involves passing the distillate in the presence of high pressure hydrogen over a catalyst bed held at high temperature. This removes sulfur, nitrogen, and oxygen from the oil while stabilizing it toward color and odor formation. It is the same finishing step that many virgin lube oil manufacturers use. In fact, the product of this type of re-refining is indistinguishable from virgin lube oil basestock when "fingerprinted" using an infra-red spectrometer.

These basestocks are used for blending into such products as motor oils, hydraulic oils, gear oils and A.T.F.'s. Finished oils are rigorously tested. For instance, motor oils are subjected to engine sequence protocols and must be approved to receive API ratings. Table 1 presents results for some of those tests using a re-refined oil from our Breslau Facility.

In addition to improved product quality, the distillation/hydrofinishing process produces no difficult by-products. The low boiling fraction can be used to fuel the plant, the vacuum distillation bottoms can be sold as an asphalt extender, and the water can be sent through the water treatment facility and discharged. The finishing step itself produces no recoverable by-products, as opposed to the sludges and oily clays of earlier technologies.

Recycled Oil Markets - As with most products, the marketability is directly related to the quality. Thus, reprocessed fuel, reclaimed industrial oils, and re-refined lube oils that meet or exceed normal virgin product specifications have little trouble with acceptance. There usually is a small discount to make them even more attractive. That combination of quality and economics results in a demand that at times exceeds supply. However, keep in mind that this industry has historically been made up of small businesses that can no longer survive, so there is a need to take advantage of this demand to expand as rapidly as possible.

TABLE 1

The following major engine test data on Breslube's SAE Grade 10W-30 motor oil meets the requirements of API SG/CC. The 10W-30 oil formulation includes Breslube's hydrotreated base oils, performance package and viscosity improvers.

	Test Results	API SG/CC Limits
Caterpillar 1H2		
Top Groove Filling, %	10	45 max
Weighted Total Demerits	31.0	140 max
CRC L-38		
Bearing Weight Loss, mg	21.8	40 max
Piston Skirt Varnish	9.6	9.0 min
10-Hour Stripped Viscosity @ 100°C, cSt	10.0	9.3-12.5
Sequence VE		
Average Engine Sludge	9.3	9.0 min
Cam Cover Sludge	8.7	7.0 min
Average Engine Varnish	5.9	5.0 min
Average Piston Skirt Varnish	6.5	6.5 min
Cam Lobe Wear, mils		
Maximum	7.6	15.0 max
Average	5.0	5.0 max
Sequence IID		
Average Engine Rust	8.7	8.5 min
Number Stuck Lifters	None	None
Sequence IIIE		
Average Engine Sludge	9.7	9.2 min
Average Piston Skirt Varnish	9.0	8.9 min
Oil Ring Land Deposits	4.2	3.5 min
Cam plus Lifter Wear, in		
Maximum	0.0009	0.0025 max
Average	0.0006	0.0012 max
Viscosity Increase @ 40°C @ 64 Hours, %	201	375 max

Results indicate control of engine deposits and oxidation while providing protection against rust, corrosion and wear.

The economics of re-refining, the most complex of the used oil recycling scenarios, involves a number of factors. Collection and transportation of huge volumes of used oil becomes a very important issue. A few million gallons a year will not suffice, but hauling oil for long distances can be very costly. The choice of proven technology is critical. Finally, marketing of large volumes of re-refined oil requires an aggressive and competent marketing organization, something the old mom-and-pop oil recyclers would never have dreamed of having.

CONCLUSION

Like many environmental problems, when the disposal of used oils is viewed from a recycling angle it becomes a win-win situation. The parties needing to dispose of the waste can be assured of an environmentally sound use of this resource if they make sure the recycler is carefully analyzing the wastes and any marketed products. The recycler contribute to the conservation of resources. The customers using the recycled products obtain a quality product at prices often below that of virgin materials. It is a solution we believe can serve us all well as we enter the twenty-first century.

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